



Climate Change Clues from Monitoring

Change is a powerful force in nature, and islands are particularly susceptible to it. We have seen unprecedented climate change in the last few decades and climatologists expect the rate of change to increase. As climate changes, significant changes in weather conditions impact the natural environment by shifting patterns of precipitation, promoting extremes in storm behavior, and influencing bird migration, invasive species spread, coral reef decline, and much more. The Pacific Island Network (PACN) undertakes systematic long-term monitoring of a wide variety of natural resources to accurately determine if change is occurring and why.

Weather and Climate

Average temperatures on Pacific islands have risen by 0.5°F over the past century. Moreover, temperatures at higher elevations in Hawaii are now increasing by 0.48°F per decade. A warming climate increases the frequency and intensity of tropical storms and droughts. Hawaii has experienced a statewide decline in rainfall over the past two decades, which is predicted to continue. Projections of future climate depend on developing models that use existing weather data. Weather information is routinely recorded at stations in and near all PACN parks. The recent addition of several new park weather stations allows for near real-time tracking of weather conditions as well as providing climate modelers with more data to better predict the future climate.



Precipitation in the lush valleys of Kalaupapa NHP is projected to be reduced, affecting ecosystems from the ridges to the ocean.

Terrestrial Vegetation and Landbirds

Higher elevation habitats in Pacific island national parks provide the primary refuge for native plants and animals. These elevations allow native birds in Hawaii to persist in areas where a threat like malaria-transmitting mosquitoes is low. Similarly, native vegetation throughout the Pacific tends to thrive where human disturbance is minimal, and conditions are not suitable for the plant and animal invaders that have transformed lower elevations. Warmer conditions allow avian disease-carrying mosquitoes to survive at higher elevations. This forces native birds to migrate even higher or face extinction. As the climate changes, these and other habitats are no longer certain refuges. Ninety-three percent of Hawaiian birds and 62% of all U.S. Pacific island birds are considered vulnerable to climate change. The NPS is doing its part to learn about landbird population changes with the conclusion of the first landbird monitoring cycle at Haleakalā NP, Hawai'i Volcanoes NP, and the NP of American Samoa. The cycle repeats at each park every five years.



A mangrove forest in American Memorial Park on Saipan Island inhabits a small tract of low-lying land between an urban area and the ocean. As sea level rises, the mangroves have nowhere left to retreat.

Wet forests, mangroves, coastal strand habitats, and sub-alpine shrublands are vulnerable vegetation communities that are also monitored on a five year cycle. Projected rises in sea level and increases in large storm frequency may impact coastal strand and mangrove forests while inland vegetation may experience drier and warmer conditions.

Invasive plant species may become even more competitive, especially at higher elevations, as climatic conditions become more suitable. The NPS monitors both established and colonizing invasive species in the same habitats where vegetation communities are monitored.



The incidence of avian malaria in Hawaii doubled from 1995-2005. 'Apapane (*Himatione sanguinea*) have shown some tolerance to the disease, but other native honeycreepers have not.

Pacific Island Network

National Park Service
U.S. Department of the Interior



Freshwater Animals, Water Quality, and Groundwater

Freshwater is the most valuable natural resource on Pacific islands for both people and the unique creatures that live in freshwater habitats. Water quality and quantity both below and above ground may be affected by climate change as rainfall declines and warmer temperatures promote evapotranspiration. At the same time, the rate of sea level rise is increasing (over one inch of rise per decade in Hawaii) and groundwater discharge to coastal environments can be reduced due to human withdrawal upslope. Treasured resources such as unique near-shore anchialine pools in Hawaii and wells on Guam may experience rising salinity as these hydrologic trends continue.

Perennial freshwater streams are rare on Pacific islands. Many still support unique native creatures especially in the upper stream reaches where invasive aquatic species are less established. The National Park Service annually monitors groundwater, water quality, and freshwater animals to provide managers the information they need to safeguard these waters and the native crustaceans, fish, and snails that inhabit them.



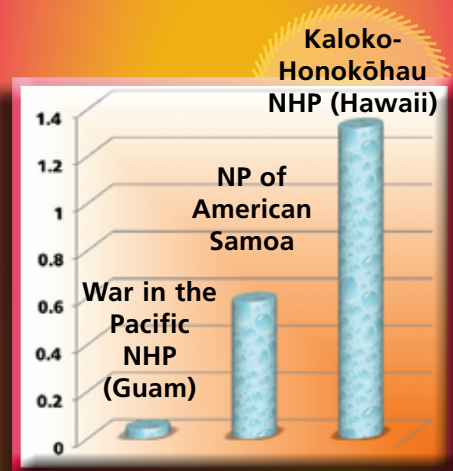
Brackish water-filled cracks in the lava near sea-level called anchialine pools may have reduced freshwater inputs.



Native coastal plant communities will experience the pressures of an encroaching ocean.



How will native species like the 'ōpae 'ōeha'a (*Macrobrachium grandimanus*) fair with less freshwater ?



Depending on the Pacific island, the sea level is currently rising at up to 1.5 inches per decade. This is altering coastal aquatic systems and coastal strand vegetation communities.

Coral Reef Communities

Oceans may absorb up to 90% of atmospheric CO₂ over the next 1000 years, providing Earth with a huge buffering capacity against even more rapid climate change. However, this is already resulting in changes to the oceans, namely ocean acidification. Coral reef ecosystems and the great diversity of creatures that depend on them are especially threatened because their stony coral skeletons will not be able to form if the water is too acidic. Coral organisms are also very sensitive to heat stress and expel their colorful symbiotic algae (bleaching) when the water warms. Bleaching due to higher sea surface temperatures is increasing in the Pacific. Disease, reduced growth, and death often follow. In the next 50 years, temperature and CO₂ levels are predicted to increase beyond levels that coral reefs have experienced for the past half-million years.

Data from marine fish and coral reef monitoring detect not only changes in fish populations, but also changes in corals, invertebrates, and algae. The reefs of Kaloko-Honokōhau NHP, Kalaupapa NHP, NP of American Samoa, and War in the Pacific NHP are surveyed annually. These ecosystems are among the most immediate and effective indicators of climate change in the region.



Coral reefs and the organisms they support are early indicators of climate change impacts.